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BENEFITS

— OF —

BACTERIOLOGICAL INVESTIGATION.

A LECTURE,

DELIVERED BEFORE THE QUARANTE CLUB,

BY DR. JOSEPH HOLT.

NEW ORLEANS, DECEMBER 15TH, 1894.

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BENEFITS OF BACTERIOLOGICAL INVESTIGATION.

Ladies—When tendered the distinguished honor of reading before the Quarante Club a paper concerning bacteriology, I must confess to having felt an overcoming sense of awe akin to terror in finding myself as one suddenly dropped into the bosom of a mighty vastness, and told to fathom the depth, to measure the breadth, and to circumscribe the bounds thereof.

As a recognized and established science, bacteriology can scarcely claim a score of years, but in this short time so wide and so deep has become this ocean of knowledge that its growing tides have swept far beyond the limits of imagination, and have lapped with the floods of knowledge in every channel of scientific research; while its receding horizon, veiled in the mists of its own mysterious depth, is lost upon the heaving ground-swell of a continuous universe.

The boldest navigator of natural philosophy has not yet sounded the experimental plummet upon the floor of its silent sea-bed; nor has he compiled the chart that establishes its meridians and parallels; nor set the limits of its benefits. Within two decades of years this new flood of science has submerged the empiricisms of learned practisers in nearly every branch of the material arts; substituting exact work with calculated results for the sanctions of time-honored traditions and the hap-hazard of unguided experiment. It has supplied in theory a working hypothesis, and in practice "the power of quantitative prevision—of assigning beforehand the precise amount of effect which will be produced by a given amount of cause,

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which is that distinguishing characteristic of scientific knowledge that enables us to predict."

However startling the first impression, a closer examination of the precise terms of the subject allotted to me reveals the tenderness of your mercy in not imposing the hopeless task of attempting an exposition of the science and technique of bacteriology, or any part of it, in one lecture.

The nomenclature alone, in alphabetic order, beginning with autogenesis, in conflict with the dictum—*omne vivum ex ovo*—the facultative aerobic and anaerobic bacteria, on through the catalytic metabolisms of the enzymes, the parasitic and saprophytic alkaloidal ptomaines or proteid toxins and deadly toxalbumens, down to phagocytes devouring bacilli and to schizomycetes, including pathogenic micrococci, staphylococci, streptococci and spirochaetes, monomorphous and polymorphous, as protoplasmic units and in zoogloæ; such as this would soon swamp in high-sounding terms of technical jargon a gracious opportunity, a precious hour along with the last vestige of your human endurance.

Except in the beatitude of convalescence from mental prostration following such a discourse, it would be impossible for you ever to associate bacteriology with benefits of any kind. These names alone would carry convincingly the evidence of diabolism in all microbes, too familiarly exemplified already in the bacillus of diphtheria and the spirillum of cholera to permit of any compromise with the germ theory, or even toleration of bacteriologists themselves on the sufficient ground that "evil communications corrupt good manners," and also, "birds of a feather," etc.

How could a schizomycete be innocent? And what must we say of its associate? You need no argument, but only your womanly intuitions, to reach a conclusion in this case.

If there is any truth in the teachings of psychic phenomena, particularly in Liebault's law of control by ob-

jective suggestion, or hypnotism, then must the "inexorable exactitude of logical deduction" at least hint the conclusion that men who seclude themselves in close communion with terrible potentialities, and pride themselves in cultures of malignancy, may well be watched. Physical taints may be morally infective, and by suggestion may encourage that corresponding inherency called original sin. But let us shut off the current and no longer focus the search light of scientific scrutiny upon the children of the household of science herself.

Fortunately for myself and the occasion, the subject for our consideration is not restricted to the limits of a science, but is lifted to the higher plane of philosophical generalization, comprehending the science and all that it touches, material and social.

In order to appreciate intelligently the benefits of bacteriology, it is well that we should briefly review some of the facts concerning germs as essential factors in the economy of nature, and their relation to all other terrestrial organisms, living and dead. But let us first examine briefly those faculties through which we came to know these things.

The development of the human race in positive knowledge has never exceeded, nor can it, the ability of the senses to perceive. The rate of material progress has coincided step by step with the rate of perceptive ability. The unseen and the unfelt was unknown, or hypothetically guessed at. Seeing only with the unaided eye, nature in gross aspect alone engaged the attention, while superstition, the logic of ignorance, furnished the working hypotheses in explanation of all phenomena. The thunderbolt and the storm, the blight and pestilence, all were explained in exact keeping with the powers of investigation. Men peered into the heavens with some notion of celestial movement, from which they contrived their science of astrology. With the enlargement of the eye by the creation of the telescopic lens, the perceptive brains of Galileo, Kepler, Newton, Laplace and others

of their kind enlarged human knowledge to correspond with their expanding vision, and established astronomy as an exact science, the progenitor of geography and the art of navigation.

Familiar with the trees and the flowers, the birds, the animals, insects and fishes, men began very early the classifications and study of structure out of which have been evolved botany and zoology. But all this while, there has existed on every hand, in air, earth and water, a vast unseen world of living things, vegetable and animal, upon the existence and special functions of which directly and necessarily depend every blade of grass, every plant, tree, insect, fish, bird and animal, including man, a little lower than the angels, crowned with glory and honor, having dominion, and with all things under his feet.

As the movement of a chronometer depends upon the perfect poise and regulating action of the balance, so does the movement of this complex scheme of life on the earth, exceeding the reach of imagination to comprehend in vastness and the refinement of ingenuity, so does this depend upon the action of this perfectly adjusted compensation balance called germ life.

To-day, by an edict of the Almighty Designer, let there be struck from this complicated mechanism, working through all its parts in reciprocating harmony as a unit—strike out this micro-organic balance trembling through the appointed arc of vibration in fine adjustment, these unseen pullers down and builders up, and to-morrow would witness a wilting and famishing, the prologue to the tragedy of universal death upon this planet; a premature enactment of the general doom.

Consider for a moment that the very existence of the present generation living upon the earth, in the sea and in the air, is conditioned upon the death and prompt removal of every organism of the preceding generation. The beautiful world about us is ever changing, but always the same. Let the microbes, these ministers of God's providence, stop their work of breaking down waste tissue and

the effete forms of tabernacles abandoned of life; let them stop this splitting up of the complex into the simple, resolving all into a few inorganic elements; let nature stop this casting back into her melting-pot the types she has used in printing the record declaring the glory of God in the illuminated pages of His handiwork, and at once the wheels of her machinery would be clogged and stopped by a jumbled mass of matter out of place. The remelting for new casts, which we call decay, would cease, while the imperishable bodies of the dead would occupy all available space, and would hold, locked in useless forms, the precious material intended for the enjoyment of successive generations in the delight of being. The possibility of living would long since have been denied by the overcrowding of the dead, and there could be no procession across the stage of life, with you and me and others yet to follow in successive order.

Again, did you ever consider that all plant life depends for sustenance upon the nourishment prepared in the soil by microbes of nitrification and other fermentative processes, akin to those of digestion in the animal?

Stop the digestive preparation, and nourishment ceases, because there can be no assimilation. The vegetable kingdom, therefore, depends upon the microbes; the animal kingdom depends upon the vegetable; besides the important office of microbes directly, in animal digestion itself.

Let us take now a glance at our daily existence in the enjoyment of those luxuries which make good digestion wait on appetite and health on both!

Our gentlemen at table, ever mindful of amenities, and that "the sauce to meat is ceremony," address themselves to delectable refectations, in which vinegar and epicurean seasonings sharpen with cloyless relish their appetites; while wines of delicate bouquet and in pleasing variety "ascend me into the brain; dry me there all the foolish, and dull, and crudy vapors which environ it; makes it apprehensive, quick, forgetive, full of nimble,

fiery and delectable shapes; which delivered o'er to the voice (the tongue), which is the birth, becomes excellent wit."

Presently they sip with flagging zest, but with infinite satisfaction, the soul-soothing *pousse café*, which illumineth the face as a beacon; they idly mince the high-toned cheese, crowning contentment in wreaths of smoke redolent of many flowers; and the while discuss, perhaps, the merits of murderous germicides. Germs made the vinegar, gave to the sauces piquancy, elaborated the wines and gave them flavor; also the brandy and the cheese, and developed fineness of aroma in the cigars.

Without the preparation furnished by the *micoderma aceti*, the *saccharomyces ellipsoideus* and other kindred germs the dinner would have been the outward form of an inward flatness; cheerless, inhospitable, the blood overcooled with thin potations, the liver left white and pale, which is the badge of pusillanimity and cowardice. Thus it is the microbes do affect our moral natures and control our social functions.

The ladies, to whose skilful management and correct taste the enjoyment of every luxury and of all else that makes life worth the living is wholly due, superintend arrangements, treating with esthetic care those ineffable graces, the angels' food and *charlotte-russe*, to serve as ceremony after meat.

In the evolution of the dessert genius droops her wings in the exhaustion of achieved success with the fruit essences. These are the souls, the ethereal spirits, which tabernacle in the cakes, custards, jellies, puddings and ices, from whence they exhale as ascending incense; the spirits of good things made perfect; like odors of sanctity about a crown of glory.

What and whence are these fruit essences, these aromatic ethyls in the pies-and-things, so charming to the still more charming Ethels around the board? They are pineapple, melon, strawberry, raspberry, gooseberry, grape, orange, jargonelle pear, quince, lemon, black

cherry, cherry, plum, apricot, peach, currant, green gage, also vanilla and banana. These are all elaborated from butyric acid, the product of the bacillus amylobacter, the microbe of putrefactive decomposition in rancid butter and cheese encouraged by the addition of sugar and chalk, with moisture, warmth and plenty of time.

Again would the feast be curtailed of fair proportion in the absence of the dessert, which, non-existent *in posse*, could not be *in esse* without the microbes. These silent, unseen workers, chief nourishers in life's feast, score another host of benefits, while the hostess and her guests, spending the time in nothing else, but either to tell or to hear some new thing about the bacillus and the serum, arraign all germ creation with maledictions vehement, though couched in phrases of propriety.

We pray for our daily bread, but have no word or thought for our saccharomyces cerevisiæ, sometimes called yeast, that furnish the rising—hence, again the “inexorable exactitude of logical deduction” that, even the most cultured of the human race, whether through ignorance or total depravity, is ungrateful.

It would be unfair for me to proceed further without mentioning that fruit essences are not all of them artificial; albeit our acceptance, in these days of scientific sophistication, must often be by faith and hope, with charity for the trade.

Had we the time to take a stroll post-prandial in this garden of the unseen world, in which and by which we live and move and have our being, we should see marvelous sights, could we but adjust our senses for a high power, microscopic gaze at our novel surroundings. Could we but withdraw our eyes from the huge forms of common experience, and inspect the teeming myriads of living creatures, animal and vegetable, that swarm in the air, in every drop of unfiltered or unboiled water, upon every surface and in every grain of soil, and study their behavior in contact with the inorganic world on the one hand and the higher forms of organic life on the other,

carefully noting the reciprocal results, this would, indeed, become knowledge. Through such investigation we might find "Whence then cometh wisdom, and where is the place of understanding? Seeing it is hid from the eyes of all living, and kept close from the fowls of the air!" We might learn why "Destruction and death say: 'We have heard the fame thereof with *our* ears.'"

However, we are forbidden in the title of this paper to enter the field of scientific investigation, but may generalize our observations. In a general way, then, we would note that the animals are bizarre in shapes and of divers colors, are voracious, never satisfied, and are always moving with prodigious energy. Most interesting to our purpose would be the vegetables, far more numerous, for it is through the digestive and nutritive changes in the natural life and growth of these, and the excretions from the substance of their bodies that all the good and the mischief of germs is accomplished, differing with each kind of germ in special or specific character.

We would note that these minute vegetable organisms are, many of them, endowed with great power of movement and locomotion, which partly accounts for their rapid diffusion through fluids, while they and their spores or seeds are borne freely by the air. We would also note that an equally important factor in rapid diffusion and widespread, is their extreme prolificness. "From actual experiment Cohn has calculated that a single germ can produce by simple fission, or self-division, two of its kind in one hour; in the second hour these would be multiplied to four, and in three days, if their surroundings were ideally favorable, would form a mass which, if reckoned in numbers, could not be imagined, but in figures would be 4772 billions; or in weight, from this single germ in three days, 7500 tons." Fortunately for us, nature has amply provided counter-checks to repress this appalling rate of development, and to regulate the distribution of microscopic life, as she does the larger creatures through

the microbes of disease and pestilence: her compensation self-adjustment.

Pursuing our course with close attention, guarded by exact methods, we would discover that throughout the entire range of the animal and vegetable, called the organic kingdoms, we find no break in the continuity of natural law governing the smallest micro-organism, upward to the most complex creatures in ocean, field and forest, reaching the climax in man.

Throughout the whole, every organism is a direct descendant of a parent organism, reproducing each according to its kind, of course allowing variation in varieties. There is no more evidence of spontaneous generation of a micrococcus or bacillus than there is of elephants and oak trees.

We have noted that each germ is endowed with its own specific functions and character of products, which cause certain effects, just as each kind of vegetable, tree and vine are specifically endowed. The ferments of beer, wine and vinegar; and in the blood, of yellow fever, septicæmia and scarlatina, the germs of mineralization and perfume production, are not interchangeable, but special and steadfast. No disease turns into some other, any more than cotton turns into pea vines. To hear a man talk about typhoid-malaria, we can but regard it as the depth of ignorance or slovenly carelessness.

Bacteriology, chief among its benefits, teaches us to know the Almighty; that He established His ways and perfected them according to His sovereignty, long ere we entered the field with our notions or our microscopes. We may get jumbled in both of these, but His plans move smoothly on, as we have said; because these ministers of His that do His pleasure execute the purpose of His will, according to their kind, specifically, and do not merge one into another in chaotic disarrangement. The whole strength of bacteriology is in its foundation upon immutable law. Through the microscope and through the tele-

scope we take merely opposite views of the same continuous universe.

In our stroll through microscopic fields we would discover that all germs are destructive of the soil in which they grow, because the elements of its substance, which constitute it a culture field, are food for the germs. The soil or field of culture, therefore, whether it be a fermenting tun of beer wort, or milk in cheese making, a pan of dough for breakfast rolls or the mucous membrane of a child's throat, supplies in its own substance the nourishment which is taken up, assimilated by and becomes the substance of the germ, undergoes chemical changes in this process of germ nutrition, and then, no longer of service, it is thrown out or excreted from the body of the germ into the surrounding medium, an entirely different substance, possessed of peculiar and special qualities, according to the kind of culture medium and the kind of germ. In one case it is an alcohol, in another an acid, an alkali, a useful enzyme, a deadly ptomaine, a still more deadly toxalbumen or albumose, a delicate perfume or a fruit flavor, etc.

Here we have, in the fewest words, the whole basis of bacteriology as an applied science in medicine and the arts. To cultivate the useful and to prevent or destroy the bad, is the *raison d'être* and practical purpose of bacteriology.

Vegetables, fish, fowl, insects, animals and man are liable to contract the relation of culture fields to certain kinds of germs, each order of beings having its unfortunate fitness in furnishing an acceptable soil to some special kinds of germs.

To protect himself in his own interests of health, and to aid his general welfare, has been the object of man's anxiety and constant effort from the earliest recorded time.

But heretofore, being able to see no further than with his natural eyes, this field of knowledge and wisdom,

opened to understanding by the microscope, had been unavailable, seeing it was hid from the eyes of all living.

Man's efforts to protect and improve his life and condition of living were vaguely speculative because of his ignorance of this undiscovered micro-organic realm, until Kircher came along with his "*Contagium Animatum*" about 1671, and Van Leeuwenhoek at the same time, or soon after, with his primitive microscope.

Ever since that day the idea and the artificial, microscopic eye have been growing, and going hand in hand. In the course of time great, perceptive brains, full of ideas, a Pasteur, a Lister, Davaine, Koch, Cohn, Burdon Sanderson, Sternberg, Reeves, Biggs, Abbott, Behring, Kitasato, Roux—with a host of co-workers, peered through a high power homogeneous, oil immersion objective, with Abbe condenser, iris blender and staining outfit.

Straightway agriculture began to be a science and an art; also sugar-making and all manufacture by fermentative processes; the dying vineyards were restored and the perishing silk industry was re-established. Not only has bacteriology thus turned the current of inventive genius into undreamed channels of protection and the arts, but already has man stretched forth his hand, and, with a voice as of divinity, has said to invading floods of foreign pestilence: "Hitherto shalt thou come, but no further; and here shall thy proud waves be stayed." From the bulwarks of his quarantine of sanitation he hurls back the imminent desolation from his shores, throwing about his children and his State, his industries and his commerce, the ægis of hygienic law.

No longer can he be ravaged and destroyed, except as a penalty of unfaithfulness and neglect.

But let me cease the vain attempt to enumerate the benefits of bacteriology, for they are coextensive with the evolution of mind in subjugation of matter, moving in the upward line of man's diviner needs. Marking the boundary between the old and the new, they henceforth register the advancing stages of man's enlightenment.

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